TABLE 4-2
TECHNOLOGY SCREENING TABLE - SOIL
IDENTIFICATION OF CANDIDATE TECHNOLOGIES
RIVERSIDE INDUSTRIAL PARK SUPERFUND SITE
NEW JERSEY

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	DESCRIPTION	SCREENING COMMENTS (Effectiveness, Implementability, and Relative Cost)	RETAINED
No Action	Not Applicable	Not Applicable	Under this response action, no active response action will be taken to address concerns regarding contaminated soil. The no action alternative is required to be considered by the NCP to provide a baseline against which all other alternatives may be compared.	Effectiveness: The no action alternative would not meet ARARs or reduce unacceptable risks to human health or the environment. Implementability: Because no action would be taken, this option is the easiest to implement. Relative cost: No capital, administrative, or O&M cost. Lowest cost alternative.	Yes
Institutional Controls/Access Restrictions	Land Use Restrictions	Deed Notice	File a Deed Notice whereby the owner agrees to subject the property to certain statutory and regulatory requirements that impose certain restrictions upon the use of the property, and to provide notice to subsequent owners, lessees and operators of the restrictions including the monitoring, maintenance, and reporting requirements that are outlined in the Deed Notice.	Effectiveness: Institutional controls would not reduce the toxicity, mobility, or volume of contaminants and would not reduce COPC concentrations to protective levels. These controls alone would not be protective of human health because soil contamination exists at concentrations greater than the PRGs. The Site is zoned as commercial, and a deed notice may be implemented to keep this designation in the future. The effectiveness of institutional controls depends on the reliability of their execution, which is most likely controlled by the local government. Implementability: Deed notices have been established for some lots that bind the property owners to certain land use restrictions, notice requirements, and the obligation to inspect and maintain any engineering controls that prevent direct contact with historic fill/soil. Enhancement of existing deed notices may be feasible to allow elevated levels of contaminated soil to remain permanently on-site. Relative cost: Periodic reporting required. Generally low-cost alternative.	Yes
		Zoning/ Ordinances	Restrictions for protection of public health. Issued and enforced by a governing body or regulatory agency. The Site is a Dedicated Industrial Zone by the City of Newark.	Effectiveness: Zoning ordinances alone would not reduce the toxicity, mobility, or volume of contaminants and would not reduce site—related contaminant concentrations to protective levels. These controls alone would not be protective of human health because soil contamination exists at concentrations greater than the PRGs. The effectiveness of ordinances depends on the reliability of their execution, which is most likely controlled by the local government. Implementability: Zoning ordinances have been established for flood zone development. Public approval of additional ordinances to further restrict Site use may be difficult to achieve initially. Ordinance enforcement would be moderately difficult. Relative cost: Generally low-cost alternative. Periodic reporting required.	Yes
	Barriers	Fencing/Signs	Erect a fence and signs around contaminated areas to restrict access and prevent contact with contaminated soils.	Effectiveness: Fencing and warning signs can be effective in reducing human exposure to contaminated soil but do not reduce the toxicity, mobility, or volume of the contamination, which would continue to pose risks to human health and the environment. These controls would not reduce contaminant concentrations to protective levels. Fencing could reduce on-site illegal activities and thus new contaminant sources. May conflict with intended Site use. May be used in conjunction with another technology. Implementability: This process option would be easily implementable for the site since equipment for this process option is readily available. Relative cost: Requires maintenance and monitoring. Periodic inspections and maintenance as required to address damage. Generally low- to moderate-cost alternative.	Yes
Engineering Controls	Cover Systems	Single-Layer Cap	Single-layer caps can consist of a synthetic membrane or a single layer of soil, clay, asphalt, or concrete. Single synthetic membrane caps are the simplest of caps designed to minimize infiltration and prevent direct contact.	Effectiveness: The engineered structure would be effective in preventing direct contact with contaminated soil, promoting runoff, and reducing infiltration and associated dissolution of COPC, but would not reduce toxicity or volume, and would not eliminate contact of groundwater with contaminated soil due shallow groundwater, tidal fluctuations, and flooding. Single-layer caps are relatively susceptible to loss of integrity, unless properly inspected and maintained. Primary drawbacks to single synthetic membrane caps are susceptibility to penetration by animals, weathering, and unequal settlement. Application often combined with use of institutional controls. An effective means of preventing direct contact with impacted soil/fill. Currently present as an engineering control at the Site. Implementability: This process option is technically implementable using conventional earthmoving equipment. The materials, experienced vendors, and equipment are readily available. Installing a cap within the 100-year flood zone could require NJDEP's approval, and would require soil erosion control measures to ensure the integrity of the cap as designed to ensure that the contaminants would not be released or pose risks to human and ecological receptors in case of flooding. Relative cost: Periodic inspections and maintenance as required to address damage. Generally moderate-cost alternative.	Yes
		Combination Cap	Combination caps consist of a synthetic membrane liner overlain by soil, with an asphalt or concrete surface layer. This type of cap can eliminate infiltration, leachate generation, air emissions, and direct contact with contaminated media and provides better protection of groundwater compared to the single-layer cap.	Effectiveness: Due to the presence of several layers, this technology is more likely to be effective in preventing direct contact to impacted soil and historic fill than a single layer cap. A low-permeability layer would help to prevent direct contact with contaminated soil, promote runoff, reduce infiltration and associated dissolution of COPC, and reduce transmission of water or vapor through the cap but would not eliminate contact of groundwater with contaminated soil due shallow groundwater, tidal fluctuations, and flooding. This technology requires maintenance and inspection to maintain integrity. Implementability: This process option is technically implementable using conventional earthmoving equipment. The materials, experienced vendors, and equipment are readily available. Installing a cap within the 100-year flood zone would require NJDEP's approval, and would require soil erosion control measures to ensure the integrity of the cap as designed to ensure that the contaminants would not be released or pose risks to human and ecological receptors in case of flooding. Relative cost: Periodic inspections and maintenance as required to address damage. Generally moderate- to high-cost alternative.	Yes
		Multimedia Cap	Multimedia caps typically have several layers composed of the following: a bedding layer installed on top of the contaminated soil, an impervious layer of clay, a second bedding layer and a second impervious layer, a drainage layer, and vegetative cover. Multimedia caps provide the greatest reduction of soil infiltration and durability compared to the single-layer cap.	Effectiveness: Due to the presence of several layers, this technology is more likely to retain its integrity than a single-layer cap for reducing COPC mobility. A low-permeability layer would help to prevent direct contact with contaminated soil, promote runoff, reduce infiltration and associated dissolution of COPC, and reduce transmission of water or vapor through the cap, but would not reduce toxicity or volume, and would not eliminate contact of groundwater with contaminated soil due shallow groundwater, tidal fluctuations, and flooding. A double low-permeability layer is typically applied as a remedy for waste in place (e.g., landfills, surface impoundments) and preserves open green space. This technology requires maintenance and inspection to maintain integrity. The surface of this cap is not suitable for roadways, parking, and material storage occurring at the Site. Implementability: This process option is technically implementable using conventional earthmoving equipment. The materials, experienced vendors, and equipment are readily available. Installing a cap within the 100-year flood zone could require NJDEP's approval, and would require soil erosion control measures to ensure the integrity of the cap as designed to ensure that the contaminants would not be released or pose risks to human and ecological receptors in case of flooding. Relative cost: Periodic inspections and maintenance as required to address damage. Generally high-cost alternative.	No

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Engineering Controls	Vertical Barriers	Slurry Wall	Slurry wall construction typically entails the excavation and backfilling of a trench with either a soil/bentonite or cement/bentonite slurry mixture. Soil/bentonite slurry walls are more flexible, achieve low hydraulic conductivities, and are cheaper than cement/bentonite slurry walls. Where superior strengths are required, cement/bentonite slurry walls can be constructed. To prevent underflow of contaminated groundwater, the slurry walls are typically keyed into underlying confining clay layers within an aquifer. Slurry walls are containment barriers that could be installed inland of the bulkhead wall to help isolate impacted soil from groundwater and the river. May be used in combination with the existing or replaced bulkhead wall to isolate impacted soil.	Effectiveness: A slurry wall would help reduce mobility of COPC and direct contact with most contaminated soil, but would not reduce toxicity or volume. Based upon subsurface voids along existing river wall between building 6 and 10, and possible wall structure tie-backs, slurry wall alignment could be 15-20 feet inland of the present wall where competent soil (needed for slurry wall trench) is likely to exist. This alignment would result in some contaminated soil "outside" of slurry wall reducing its effectiveness. Furthermore, slurry wall construction methods preclude installation along the river bank to prevent erosion or sloughing of Site soils. A slurry wall would not be effective for isolating COPC in soil. Implementability: A slurry wall would be difficult to implement. Active buried infrastructure and building foundations would need to be avoided, removed, or rerouted. Installation may be disruptive to current commercial operations. At some locations (i.e. Buildings 7, 10, and 17) there is insufficient space between river and existing buildings. Geotechnical study of barrier alignment and possible effects on adjacent structures would be needed. Relative cost: No anticipated maintenance. Generally moderate- to high-cost alternative.	Yes
		Shoreline Revetment	Riprap or interlocking concrete block is placed on a prepared subgrade to absorb the energy of waves or flowing water as defense against erosion to help protect the slope and preserve the existing uses of the shoreline.	Effectiveness: Revetment would be installed to enhance or in lieu of the existing bulkhead. Revetment would be placed on a prepared slope and sized according to anticipated maximum flow velocities. Some encroachment into access routes that are immediately inland of the existing wall (i.e., Lots 60 and 61) would be inevitable. At some locations (i.e., Buildings 7, 10, and 17), there are space limitations between the river and existing buildings. If buildings remain, river encroachment is likely. Revetment installation could be complemented by installing berms to control surface water. A geomembrane could be placed under the revetment to reduce potential Site and river interaction (soil and groundwater). Implementability: Implementation of shoreline revetment would require landowner consent and coordination with future redevelopment plans which may pose some difficulty. Inactive river wall pipes would be sealed. Would require a geotechnical investigation for geomembrane installation termination design. If the design includes working below the mudflat to install a geomembrane, the difficulty of construction would be relatively high. Relative costs: Requires maintenance to address damage as identified through routine inspection, especially following extreme precipitation events, to maintain effectiveness. Generally moderate-cost alternative, depending on maintenance requirements from extreme events.	Yes
		Sheet Piling	Sheet pile barrier walls are formed by driving interlocking sheet piles constructed of steel, wood, concrete, or plastic to isolate the contaminated soil from the surrounding environment.	Effectiveness: A barrier would be installed to protect the riverbank from erosion and slumping and reduce potential infiltration from and potential exfiltration to the river. The barrier would reduce the mobility of COPC and exposure by direct contact with contaminated soil, but would not reduce toxicity or volume. If extended above ground surface, a barrier could also help prevent river flooding. Would not serve as an earth retaining structure unless waling and buried tiebacks are also installed. Existing occupied buildings could limit wall placement to more inland portions of the Site. May be used in combination with or in lieu of the existing bulkhead. At some locations (i.e., Buildings 7 and 10), there are space limitations between the river and existing buildings. If buildings remain, river encroachment is likely. Implementability: Demonstration of permit equivalencies would require several months. Geotechnical study of barrier design and possible effects on adjacent structures needed. Quality control is required to ensure proper interlocking of the sheets. Active buried infrastructure and building foundations may need to be removed, avoided or rerouted. Installation may be disruptive to current commercial operations. At some locations (i.e., Buildings 7, 10, and 17) there is insufficient space between river and existing buildings. If buildings remain, river encroachment is likely which would increase the difficulty of implementation. Inactive river wall pipes would be sealed. This technology would be implemented with difficulty using specialty equipment and contractors. Relative cost: Requires maintenance to address damage as identified through routine inspection of exposed portions of the barrier. Generally high-cost alternative.	Yes
		Soil Berm	An earthen dike would be placed along the riverbank to help contain river flow onto the Site during flooding events.	Effectiveness: A dike would likely be an ancillary technology to another form of vertical barrier as a component of an alternative depending on ground surface elevation and relative barrier height to raise the total elevation of the remedy and help control surface water movement onto the Site from the river and potential offsite transport of soil containing COPCs. Soil berms would not reduce the toxicity, mobility, or volume of COPC. If extended above ground surface, a barrier could also help prevent river flooding. Would not serve as an earth retaining structure. Existing occupied buildings could limit berm placement to more inland portions of the Site. May be used in combination with the existing bulkhead. At some locations (i.e., Buildings 7, 10, and 17), there is insufficient space between the river and existing buildings. If buildings remain, river encroachment is likely. Implementability: An earthen berm would be readily implemented. Bulkhead stabilization or improvement could be required if a soil berm is used in combination with the existing bulkhead. Conventional earthmoving equipment and contractors would install clean (i.e., non-contaminated) fill. At some locations (i.e., Buildings 7, 10, and 17) there is insufficient space between river and existing buildings. If buildings remain, river encroachment is likely which would increase the difficulty of implementation. Relative cost: Requires maintenance to address damage as identified through routine of the berm. Generally low-cost alternative.	Yes

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Removal	Excavation	Mechanical	Contaminated soil is excavated using conventional excavation equipment. Depending upon the vertical extent of the contaminated soils, dewatering may be required. Sheeting and shoring may be required, depending upon depth and geotechnical conditions. Removal of soil below the groundwater table is not anticipated due the volume of water and soil that would be generated, given the extent of urban fill.	Effectiveness: Excavation is effective for removal where equipment can access the contaminated materials and has space to maneuver. Depending on the extent of excavation, it could completely remove the contamination exceeding the PRGs or leave some residual contamination. However, excavation alone would not reduce the toxicity, mobility, or volume of the contaminants. Excavation is a common construction technique. The excavated soils can either be treated and placed back into the excavation or shipped off-site for treatment/disposal. In the latter case, backfilling with clean (i.e. contaminant free) fill, of appropriate geotechnical properties may be necessary. Implementability: Excavation is technically and administratively feasible at the Site. The presence of subsurface infrastructure such as utilities, tanks and vaults, buildings and building foundations, bulkheads and bulkhead tie-backs may interfere with or prevent excavation. Site redevelopment prior to or in coordination with remediation could mitigate these potentially interfering subsurface features. Requires confirmation sampling. Relative cost: No anticipated long-term maintenance. Generally moderate- to high-cost alternative.	Yes
Treatment	In-Situ Treatment (Biological)	Phytoremedia-tion	The use of plants to remediate environmental media in situ. May or may not involve periodic harvesting of plants, depending upon method utilized. Most effective where constituent containing soil is within ten feet of the ground surface.	Effectiveness: Metabolic reactions with certain organic compounds (e.g., solvents, explosives and crude oil) and uptake of certain metals could reduce volume and mobility of select COPC. Phytoremediation would be limited by the ability of soil to support vegetation, availability of plant species that tolerate and uptake Site contaminants, and duration of growing season. In addition, limited area not currently in use for industrial purposes or planned for future use as such make this technology unattractive. Implementability: Phytoremediation requires a long-term commitment and would be relatively labor intensive with specialized knowledge. May require bench scale/pilot studies during design. Based upon zoning, expected future use, and minimal open space for planting, this technology would be very difficult to implement and is not well suited for the Site. Relative cost: Requires periodic inspections, replacement/harvesting, and confirmation sampling. Generally low- to moderate-cost alternative.	No
		Bioventing	Air is drawn through the impacted vadose zone via extraction wells equipped with low flow vacuums to promote biodegradation by providing only enough oxygen to sustain microbial activity in the vadose zone.	Effectiveness: Applicable only to certain organic contaminants, such as heavier petroleum hydrocarbons (i.e., not readily treated by SVE). This technology would not reduce the toxicity, mobility, or volume of inorganic COPC. Highly dependent on soil geotechnical properties such as air permeability and homogeneity. May require engineering controls due to residual inorganics. Implementability: Implementation of bioventing would be moderately difficult and would need to be coordinated with future Site development to avoid interference with intended land use. May require bench scale/pilot studies during design. Requires a continuous source of energy, blower operation, and confirmation sampling. Relative cost: Generally moderate-cost alternative. No anticipated long-term maintenance.	Yes
	In-Situ Treatment (Physical)	Electrokinetic Remediation	Application of low intensity direct electrical current across electrode pairs implanted in the ground on each side of a chemical containing area of soil, causing electro-osmosis and ion migration. Chemical constituents migrate toward respective electrodes depending upon their charge. Process may be enhanced through use of surfactants or reagents to increase chemical constituent removal rates at the electrodes. Process separates and extracts heavy metals, radionuclides, and organic chemical constituents from saturated or unsaturated soils, sludges, and sediments.	Effectiveness: The presence of buried features such as utility lines, building foundations, irregular/heterogeneous fill can adversely impact efficacy. Methodologies are innovative with limited application history. This technology is not well suited for this Site due to the prevalence of buried metal and soil heterogeneity (density and permeability) which would limit effectiveness. Implementability: The electrokinetic technology would be relatively easy to implement in select areas where buried metal is not as abundant. May require bench scale/pilot studies during design. Relative cost: Requires a continuous source of energy, electrode maintenance, treatment or removal of separated chemical constituents, and confirmation sampling. No anticipated long-term maintenance. Generally high-cost alternative.	No
		Soil Vapor Extraction (SVE)	A vacuum (much greater air exchange than bioventing) is applied to the subsurface though a well network to create a negative pressure gradient that causes the movement of vapors toward the extraction wells. Contaminants are drawn to a collection points and extracted. Extracted vapors are treated, as necessary, and discharged to the atmosphere.	Effectiveness: Applicable only to certain volatile and semi-volatile contaminants, such as petroleum hydrocarbons. The toxicity, mobility, and volume of inorganics would not be reduced. More successful with lighter (more volatile) compounds, such as gasoline. Highly dependent on soil geotechnical properties such as air permeability and homogeneity. Due to high water table (i.e., 4 to 10 feet below ground surface) and corresponding thin vadose zone, short-circuiting to the atmosphere is likely without an impermeable cover layer. Additional treatment of contaminants after collection may be required. Retained for possible application under building foundations to mitigate vapor intrusion where the foundation subbase is likely to provide a permeable, continuous, homogenous layer below the slab. Implementability: SVE is readily implementable with conventional drilling, plumbing, and electrical trades. May require bench scale/pilot studies during design. If vapor treatment is required, spent treatment media would need to be removed for disposal or regeneration. Relative cost: Requires a continuous source of energy, blower operation, and confirmation sampling. No anticipated long-term maintenance. Generally moderate-cost alternative.	Yes
		Air Stripping and Air Sparging	An array of injection wells is used to inject gas (e.g., air, oxygen, or ozone) under pressure to volatilize chemicals sorbed to soil, dissolved in groundwater, or present as non-aqueous phase liquid and to stimulate biodegradation in unsaturated soil. Oxygen levels, nutrients, and pH can be controlled to enhance biological activity.	Effectiveness: Applicable only to volatile organic contaminants. The toxicity, mobility, and volume of inorganics would not be reduced. Highly dependent on soil geotechnical properties such as air permeability and homogeneity. Due to high water table (i.e., 4 to 10 feet below ground surface) and corresponding thin vadose zone, short-circuiting to the atmosphere is likely without an impermeable cover layer. In addition, due to fluctuating water table, vaporized contaminants in the vadose zone at low tide could re-enter the aqueous phase at high tide, reducing overall efficiency. Implementability: Air sparging and air stripping is readily implementable with conventional drilling, plumbing, and electrical trades. May require bench scale/pilot studies during design. If vapor treatment is required, spent treatment media would need to be removed for disposal or regeneration. Relative cost: Requires a continuous source of energy, blower operation, and confirmation sampling. No anticipated long-term maintenance. Generally moderate-cost alternative.	Yes

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Treatment	In-Situ Treatment (Physical)	Multi-phase Extraction (MPE)	MPE is a technology that extracts soil vapor and groundwater simultaneously. The groundwater table is lowered in order to dewater the saturated zone. This allows the VOCs sorbed on the previously saturated soil to be stripped by the induced vapor flow and extracted. In addition, soluble VOCs in the extracted groundwater are removed. There are two types of MPE: two-phase extraction (TPE) and Low or High Vacuum Dual-Phase extraction.	Effectiveness: Applicable only to volatile organic contaminants. The toxicity, mobility, and volume of inorganics would not be reduced. Highly dependent on soil geotechnical properties such as air permeability and homogeneity. Vadose zone thickness and variability due to tidally influenced groundwater elevations is not amenable to this technology. Implementability: MPE is implementable with moderate difficulty requiring specialized contractors. May require bench scale/pilot studies during design. If vapor treatment is required, spent treatment media would need to be removed for disposal or regeneration. Dewatering could generate significant water volumes for management/treatment/disposal. Relative Cost: Requires a continuous source of energy, blower operation, and confirmation sampling. No anticipated long-term maintenance. Generally moderate-cost alternative.	No
		Soil Flushing - Surfactant-Enhanced Aquifer Remediation	A surfactant solution is injected into the constituent containing zone while water is simultaneously removed to maintain hydraulic control over the movement of the surfactant solution and the mobilized chemical constituents. Surfactant flooding is followed by water flooding to remove residual chemical constituents and injected chemicals.	Effectiveness: Highly dependent on soil geotechnical properties such as permeability and homogeneity and contaminant sorption properties as influenced by soil geochemistry. The toxicity, mobility, and volume of COPC in vadose zone soil would not be reduced. Implementability: Soil fushing is implementable with moderate difficulty and would need specialized contractors. The tidal influence on the saturated zone may necessitate significant design and operational controls to maintain surfactant recovery. May require bench scale/pilot studies during design. Relative cost: Requires a continuous power source, pumping, confirmation sampling, and treatment of extracted flushing liquids. No anticipated long-term maintenance. Generally high-cost alternative.	No
		Cosolvent Flushing	Cosolvent flushing involves injecting a solvent mixture (e.g., water plus a miscible organic solvent such as alcohol) into either vadose zone, saturated zone, or both to extract organic chemical constituents.	Effectiveness: Highly dependent on soil geotechnical properties such as air permeability and homogeneity and contaminant sorption properties as influenced by soil geochemistry. Implementability: Cosolvent fushing is implementable with moderate difficulty and would require specialized contractors. The tidal influence on the saturated zone may necessitate significant design and operational controls to maintain solvent recovery. May require bench scale/pilot studies during design. Relative cost: Requires a continuous power source, pumping, confirmation sampling, and treatment of extracted flushing liquids. No anticipated long-term maintenance. Generally high-cost alternative	No
		Thermal Remediation	Thermal heating uses electrical resistance or gas well heating techniques to remove sorbed organics contaminants by heating the subsurface sufficiently to vaporize the organics. This technology can be applied to chemicals in both the vadose and saturated zones. The volatile organic compound vapors are recovered through vapor extraction wells.	Effectiveness: Limited to only to organic contaminants. The toxicity, mobility, and volume of COPC in vadose zone soil would not be reduced. Additional treatment of contaminants after collection is required. Shallow water table may lead to inefficiency as energy needed to vaporize organics is lost to groundwater. Implementability: Significant energy inputs (electricity or gas) is necessary, which may take several months to procure. The treatment system may require permitting. May require bench scale/pilot studies during design. Relative cost: Requires a continuous power source, heating and blower operation, confirmation sampling, and treatment/disposal of condensate. No anticipated long-term maintenance. Generally high-cost alternative.	No
	In-Situ (Chemical)	In-situ Chemical Oxidation (ISCO)	Chemical oxidation by injecting and mixing oxidizing agents such as hydrogen peroxide, sodium and potassium permanganate, ozone, sodium and potassium persulfate. Most organic contaminants are amenable to oxidation.	Effectiveness: Would reduce toxicity, mobility, and volume of organic COPC in soil. Ambient oxidant demands must be estimated, to develop a proper dosing regimen. Implementability: Would be implemented with moderate difficulty using conventional excavating equipment and potentially proprietary treatment agents. Bench scale testing and treatability/pilot study may be required during design. Relative cost: Requires post-treatment demonstration sampling and possibly multiple mixing events. Generally moderate-cost alternative.	Yes
	In-Situ Treatment (Thermal)	Steam Stripping	Steam is injected into soil so that chemical constituents are volatilized and can be removed via extraction wells.	Effectiveness: Limited to only to organic contaminants. Additional treatment of contaminants after collection is required. The toxicity, mobility, and volume of COPC in vadose zone soil would not be reduced. Significant energy inputs (electricity or gas) is necessary to generate steam. Shallow water table may lead to inefficiency as energy needed to vaporize organics is lost to groundwater. Effectiveness is highly dependent on soil geotechnical properties such as air permeability and homogeneity. Due to shallow groundwater, control and collection of steam is likely to be difficult. Implementability: Steam stripping would be difficult to implement. Significant energy inputs (electricity or gas) is necessary, which may take several months to procure. The treatment system may require permitting. May require bench scale/pilot studies during design. Relative cost: Requires continuous energy input, compressor and blower operation, confirmation sampling, and treatment of collected steam and condensate. Generally high-cost alternative	No
		Vitrification	Uses an electric current to melt soil or other earthen materials at extremely high temperatures (2,900 to 3,650°F). Inorganic chemical constituents are incorporated into the vitrified glass and crystalline mass and organic pollutants are destroyed by pyrolysis. In situ applications use graphite electrodes to heat soil.	Effectiveness: Interference from buried features (e.g. utilities, building foundations) are expected to adversely impact application. Impacts of heat generation on neighboring users and receptors must be accounted for. Due to shallow groundwater, significant steam generation is anticipated and energy needed to pyrolyze organics is lost to groundwater. Effective control and collection of steam is likely to be difficult. Implementability: Vitrification would be difficult to implement. Significant energy inputs (electricity or gas) is necessary, which may take several months to procure. The treatment system may require permitting. May require bench scale/pilot studies during design. Relative cost: Requires significant energy input, blower operation, and treatment collected steam/vapors. No anticipated long-term maintenance. Generally, very high-cost alternative.	No

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Treatment	In-Situ Treatment (Immobilization)	Stabilization/ Solidification (Organic and Inorganic Based)	Chemical immobilization of materials by injecting and mixing a stabilization/solidification agent into the soil.	Effectiveness: Stabilization/solidification would reduce mobility, but not toxicity or volume of COPC. Near-surface pressure injection of dissolved or suspended treatment agents in heterogeneous Site soils may result in uneven mixing (i.e., poor penetration in fine-grained soil, and preferential flow along utility corridors). Interference from buried features (e.g. utilities, building foundations) may adversely impact mechanical mixing in some areas. Community impacts from odors and contaminant volatilization must be controlled. Implementability: Stabilization/solidification would be readily implemented using conventional earthmoving equipment, with some specialized expertise to determine reagent type and mixing ratios. Mixing to the top of the water table is anticipated to allow incorporation of Site groundwater for hydrolysis. Extensive treatability testing and mixing regiment studies may be required during design. Relative cost: Requires stabilization/solidification agent, mixing or injection, and confirmation sampling. No anticipated maintenance. Generally moderate-cost alternative.	Yes
Treatment	Ex-Situ Treatment (Immobilization)	Stabilization/ Solidification (Organic and Inorganic Based)	Chemical immobilization of materials by excavating and mixing a stabilization/solidification agent into the soil.	Effectiveness: Stabilization/solidification would reduce mobility, but not toxicity or volume of COPC. Coarse fill materials (e.g. concrete, wood) must be separated. Community impacts from odors and contaminant volatilization must be controlled. Excavation to the top of the water table is anticipated. Implementability: Stabilization/solidification would be readily implemented using conventional earthmoving equipment, with some specialized expertise to determine reagent type and mixing ratios. Extensive treatability testing and mixing regiment studies may be required during design. Would require off-site disposal and backfilling with clean (i.e., contaminant-free) fill. Relative cost: Requires excavation, confirmation sampling, stabilization/solidification agent, mixing, and off-site disposal of treated soil. No anticipated maintenance. Generally moderate-cost alternative.	Yes
	Ex-Situ Treatment (Extraction)	Solvent Extraction	A solvent is used to extract organic chemical constituents from excavated soils. The solvent is separated from the materials and reused.	Effectiveness: Coarse fill materials (e.g. concrete, wood) must be separated. Limited to organics. Would not reduce mobility, toxicity, or volume of inorganic COPC. Results are variable depending on geotechnical and geochemical conditions. Typically applied to limited areas with significant impacts (hot spots). Implementability: Solvent extraction is implementable with moderate difficulty due to the need for specialized contractors. May require bench scale/pilot studies during design. Relative cost: Requires excavation, confirmation sampling, solvent, pumping/recirculation, and treatment/disposal of solvent. No anticipated long-term maintenance. Generally high-cost alternative.	No
	Ex-Situ Treatment (Thermal)	Thermal Desorption	Chemical constituents are separated from the excavated soils at a relatively low temperature and are condensed into a concentrated liquid form suitable for transport offsite to a traditional treatment or disposal facility.	Effectiveness: Coarse fill materials (e.g. concrete, wood) must be separated. Limited to organics. Would not reduce mobility, toxicity, or volume of inorganic COPC. Treated soil may contain residual organics or metals. Typically applied to limited areas with significant impacts (hot spots). Implementability: Thermal desorption is implementable with moderate difficulty due to the need for specialized contractors. May require bench scale/pilot studies during design. PCB Aroclor concentrations above 50 ppm have not been encountered at the Site, but if reported during the pre-design investigation, appropriate actions will be taken. Relative cost: Requires excavation, confirmation sampling, a continuous power source, heating and blower operation, and treatment/disposal of condensate. No anticipated long-term maintenance. Generally high-cost alternative.	Yes
		Incineration	Excavated soils are thermally treated in a fluidized bed, rotary kiln, cement kiln, or infrared incinerator, which may require RCRA permitting. Incineration may be performed on-site or off-site using mobile or fixed facilities.	Effectiveness: Coarse fill materials (e.g. concrete, wood) must be separated. Limited to organics. Would not reduce mobility, toxicity, or volume of inorganic COPC. Implementability: On-site incineration would be difficult to implement due to the need for specialized contractor and permitting requirements. Requires a significant energy source, which may require months to procure and/or generate significant greenhouse gas. May require bench scale/pilot studies during design. Off-site incineration at an existing permitted facility is implementable but will require rail transport to an out of state facility, PCB Aroclor concentrations above 50 ppm have not been encountered at the Site, but if reported during the pre-design investigation, appropriate actions will be taken. Relative cost: Requires excavation, dewatering and confirmation sampling. On-site treatment will require significant energy input, airborne particulate removal, acid gas neutralization, disposal of captured particulates and ash, and air monitoring. Off-site treatment will require rail transport. No anticipated long-term maintenance. Generally, very high-cost alternative.	Yes, for off-site treatment only.
		Pyrolysis	Pyrolysis is a process of destructive distillation, using a reduced oxygen atmosphere. Organic contaminants are thermally decomposed into ions. The process converts waste into a clean product gas and an inert vitrified slag that requires no further waste treatment and is suitable for long term storage or reuse.	Effectiveness: The volume and toxicity of organic COPC and the mobility of inorganic COPC would be reduced. Significant amounts of energy are required. Coarse fill materials (e.g. concrete, wood) must be separated. Implementability: Requires a significant energy source, which may be difficult to procure and/or generate significant greenhouse gas. May require bench scale/pilot studies during design. Relative cost: Requires excavation, confirmation sampling, significant energy input, airborne particulate removal, acid gas neutralization, disposal of captured particulates and ash, and air monitoring. No anticipated long-term maintenance. Generally, very high-cost alternative	No
		Vitrification	Uses an electric current to melt soil or other earthen materials at extremely high temperatures (2,900 to 3,650°F). Inorganic chemical constituents are incorporated into the vitrified glass and crystalline mass and organic pollutants are destroyed by pyrolysis.	Effectiveness: The volume and toxicity of organic COPC and the mobility of inorganic COPC would be reduced. Significant amounts of energy are required. Coarse fill materials (e.g. concrete, wood) must be separated. Implementability: Requires a significant energy source, which may be difficult to procure and/or generate significant greenhouse gas. May require bench scale/pilot studies during design. Relative cost: Requires excavation, confirmation sampling, significant energy input, airborne particulate removal, acid gas neutralization, disposal of captured particulates and ash, and air monitoring. No anticipated long-term maintenance. Generally, very high-cost alternative	No

TABLE 4-2
TECHNOLOGY SCREENING TABLE - SOIL
IDENTIFICATION OF CANDIDATE TECHNOLOGIES
RIVERSIDE INDUSTRIAL PARK SUPERFUND SITE
NEW JERSEY

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	DESCRIPTION	SCREENING COMMENTS (Effectiveness, Implementability, and Relative Cost)	RETAINED
Treatment	Ex-Situ Treatment (Biological)	Landfarming/ Composting	Soil is mixed with amendments and placed on a treatment area. Leachate collection is provided. The soil and amendments are mixed using a windrow composter, conventional tilling equipment, or other means to provide aeration. Moisture, heat, nutrients, oxygen, and pH can be controlled to enhance biodegradation. Other organic amendments such as wood chips or alfalfa are added to composting systems. Land-farmed soil would either be used as backfill in excavated areas or removed for off-site disposal.	Effectiveness: Landfarming would be effective in reducing volume and toxicity of organic COPC, but would not reduce toxicity, mobility, or volume of inorganic COPC. Coarse fill materials (e.g. concrete, wood) must be separated. Due to inorganic residuals, landfarming would be an ancillary technology to containment and/or institutional controls. Implementability: Landfarming would be difficult to implement due to significant space and time requirements conflicting with current and anticipated land use/redevelopment. May require bench scale/pilot studies during design. Potential community impacts from odors and contaminant volatilization must be controlled. May require procurement of off-site clean (i.e., contaminant-free) soil for backfilling excavations. Relative cost: Requires excavation, confirmation sampling, amending agents, mixing, leachate treatment/disposal, and vapor collection/treatment. No long-term maintenance. Generally low- to moderate-cost alternative.	No
		Biopiles	Excavated soil is mixed with amendments and placed in aboveground enclosures and aerated with blowers or vacuum pumps. Moisture, heat, nutrients, oxygen, and pH can be controlled to enhance biodegradation.	Effectiveness: Biopiles would be effective in reducing volume and toxicity of organic COPC, but would not reduce toxicity, mobility, or volume of inorganic COPC. Coarse fill materials (e.g. concrete, wood) must be separated. Due to inorganic residuals, biopiles would be an ancillary technology to containment and/or institutional controls. Implementability: Biopiles would be difficult to implement due to significant space and time requirements conflicting with current and anticipated land use/redevelopment. May require bench scale/pilot studies during design. Potential community impacts from odors and contaminant volatilization must be controlled. May require procurement of off-site clean (i.e., contaminant-free) soil for backfilling excavations. Relative cost: Requires excavation, confirmation sampling, mixing, leachate treatment/disposal, and vapor collection/treatment. No long-term maintenance. Generally low- to moderate-cost alternative.	No
	Ex-Situ Treatment (Chemical)	Chemical Oxidation	Chemical oxidation by mixing oxidizing agents such as hydrogen peroxide, sodium and potassium permanganate, ozone, sodium and potassium persulfate. Most organic contaminants are amenable to oxidation.	Effectiveness: Would reduce toxicity, mobility, and volume of organic COPC in soil. Ambient oxidant demands must be estimated, to develop a proper dosing regimen. Implementability: Would be implemented with moderate difficulty using conventional excavating equipment and potentially proprietary treatment agents. Bench scale testing and treatability/pilot study may be required during design. Relative cost: Requires post-treatment demonstration sampling and possibly multiple mixing events. Generally moderate-cost alternative.	Yes
Beneficial Reuse	Beneficial reuse	On-Site Fill	Soil testing (treated or untreated) results would be used to demonstrate attainment of appropriate cleanup standards for on-site placement as excavation backfill or other beneficial use.	Effectiveness: Beneficial reuse is only suitable for material with low concentrations of contaminants. May be an ancillary technology to on-site treatment. Implementability: Beneficial reuse would be readily implementable following testing and determination of equivalency with NJDEP's "Fill Material Guidance for SRP Sites" dated April 2015. Coarse fil materials (e.g., concrete) may need to be segregated to suit reuse criteria (i.e., road base material, engineered fill, etc.). Conventional earthmoving equipment would be used for debris segregation. Off-site disposal of debris and oversized materials may be required. Relative cost: Requires soil/fill testing and possible off-site disposal of segregated unsuitable fill material. Generally low- to moderate-cost alternative.	Yes
Disposal	Disposal (off-site)	Solid Waste or Hazardous Waste Landfill	Excavated soils are transported to an appropriate licensed facility for landfilling, or beneficial reuse. Treatment prior to disposal may be necessary.	Effectiveness: Landfill disposal is effective in preventing direct contact with and reducing the mobility of contaminants. The volume and toxicity of the waste would not be reduced unless treatment is conducted. Implementability: This technology is readily implementable. Depending on the daily capacity of the disposal facility, production rates may be limited. Soils must be characterized prior to disposal. Disposal restrictions may require pretreatment prior to disposal. Relative cost: Requires waste characterization and disposal fees. Trucking costs can be significant. No long-term maintenance. Generally moderate- to high-cost alternative.	Yes